AMENDMENT UNDER 37 C.F.R. § 1.114(c)
Application No. 10/049,188
Attorney Docket No. Q63028

REMARKS

The Office Action of April 25, 2006, has been received and its contents carefully considered.

Upon entry of the claim amendments, Claims 1, 17-23, and 26-30 will be all the claims pending in the application.

I. RESPONSE TO REJECTION UNDER 35 U.S.C. § 103

Claims 1, 17-18, 21-24, 26-27, and 29-30 have been rejected under 35 U.S.C. § 103(a) as obvious over EP '638 in view of JP '571, Nishimura et al, Hager et al, Masuko et al and Iijima.

Applicants submit that these documents do not disclose or render obvious the subject matter of the above claims and, accordingly, request withdrawal of this rejection.

Claim 1, as amended above, is directed to a fuel cell comprising an electrolyte sandwiched by electrodes having a catalyst layer and a gas diffusion layer, or an assembly for a fuel cell comprising an electrolyte sandwiched by electrodes having a catalyst layer and a gas diffusion layer, characterized in that the gas diffusion layer comprises a layer containing a water repellant resin and a graphitized vapor grown carbon fiber containing boron in an amount of 0.01-10 mass% and having a fiber filament diameter of 100-300 nm, wherein at least part of the surface of the gas diffusion layer is in contact with the catalyst layer.

Thus, applicants have amended Claim 1 to delete therefrom the previous recitation of a catalyst layer (i). Applicants also have amended Claim 1 to include the recitations of Claim 24 to recite that the vapor grown carbon fiber contains boron in an amount of 0.01-10 mass%, and

to recite that the diameter of the vapor grown carbon fiber is 100-300 nm. Support for the 100 nm value can be found in Example 1 of the present specification.

Applicants have made similar amendments to Claims 17, 22, and 29.

The examiner asserts that EP '638 discloses all of the recitations of the present claims, except that EP '638 does not disclose that the carbon fibers in the gas diffusion layer are the presently claimed graphitized vapor grown carbon fibers.

The examiner relies on JP '571 for a teaching of a gas diffusion electrode comprised of PTFE and vapor grown carbon fibers having a fiber filament of 200 to 500 Angstroms, that is, 20 to 50 nm. The examiner argues that it would have been obvious to employ this gas diffusion layer of JP '571 in the gas diffusion electrode of EP '638, because JP '571 discloses that such a gas diffusion layer improves the gas permeability and electrical conductivity of the gas diffusion layer. In addition, the Examiner relies on Nishimura et al, Hager, et al, Masuko et al and Iijima for various features of the present claims.

EP 638 discloses a fuel cell electrode having a catalyst layer on a water-repellant baked plate, the catalyst layer comprising electroconductive particles carrying a catalytically active component in a binder, the water-repellant baked plate comprising a carbon paper, comprising carbon fiber and an organic binder, and polytetrafluoroethylene infiltrated into voids of this carbon paper.

However, this carbon fiber of EP '638 is a general carbon fiber having a diameter of 20 μm or more, and is not a graphitized vapor grown fiber (graphitized VGCF) containing boron

in an amount of 0.01-10 mass% and having a diameter of 100-300 nm, which are features of the claimed fuel cells and assemblies.

The carbon fiber of EP '638 is completely different from the presently claimed graphitized vapor grown carbon fiber.

The carbon fiber of EP '638 is a thick and long carbon fiber and the surface thereof is uneven. Also, the diameter is different. The fiber length determined from diameter and aspect ratio has an important meaning as can be seen from the present specification, as described below.

Furthermore, the presently claimed graphitized VGCF is excellent in electrical conductivity and crystallinity and has poor wettability. That is, the presently claimed VGCF is excellent in water repellency and electrical conductivity. Accordingly, the claimed fuel cells and assemblies have a remarkable effect as a fuel material.

As disclosed in the present specification at page 18, lines 6 to 27, examples of fibrous carbon include PAN-based fibrous carbon, pitch-based fibrous carbon, vapor grown fibrous carbon, and carbon fiber having a fiber filament diameter of nanometers, which is called "nano-tube." However, since pitch-based carbon fiber or PAN-based carbon fiber has a long fiber filament length, the carbon fiber is not uniformly mixed with a catalyst easily. Therefore, in consideration of uniform mixing with a catalyst and conductivity, a nano-tube or vapor grown carbon fiber (hereinafter the fiber may be abbreviated as "VGCF") is preferably used. Particularly, VGCF which has been heat-treated and exhibits enhanced electrical conductivity is preferred, since the VGCF has appropriate elasticity. As discussed above, the presently claimed VGCF are graphitized.

Therefore, applicants submit that EP '638 is essentially different from, and does not disclose or suggest, the claimed fuel cells and assemblies.

JP '571 does not supply the deficiencies of EP '638.

Thus, JP '571 does not disclose or suggest the graphitized vapor grown carbon fiber that is employed in the present fuel cells and assemblies. Accordingly, the combination of the teachings of EP '638 with those of JP '571 would not lead one of ordinary skill in the art to the present invention.

In particular, JP '571 discloses a gas diffusion electrode material comprising water-repellant polymer particles and a composite-structure acetylene black in which fibrous carbon having a diameter of 20-50 nm is vapor-grown in voids in the carbon black material.

However, the fibrous carbon of the composite-structure acetylene black of JP '571 is grown in voids in the carbon black material, which is different from a graphitized vapor grown carbon fiber containing boron in an amount of 0.01-10 mass% and having a diameter of 100-300 nm, of the present fuel cells and assemblies.

If the fibrous carbon of the composite-structure acetylene black of JP '571 is graphitized, the acetylene black or the gas diffusion electrode is deteriorated. Therefore, it is difficult to derive the claimed fuel cells and assemblies from JP '571.

Further, JP '571 discloses a phosphoric acid-type fuel cell, but does not disclose or suggest the present solid polymeric electrolyte-type fuel cell.

JP '571 does not disclose or suggest the graphitized vapor grown carbon fiber that is employed in the present fuel cells and assemblies.

As disclosed in the present specification at page 20, line 28 to page 21, line 1, with respect to the carbon fiber employed in the gas diffusion layer, when vapor grown carbon fiber (VGCF) is heat-treated at 2,000°C or higher, not only electrical conductivity but also characteristics such as chemical stability and thermal conductivity are improved. Therefore, when the thus-treated VGCF is used in combination with a catalyst for a fuel cell, power-generating efficiency (the amount of power generated on the basis of unit volume) of the resultant fuel cell is enhanced, and durability of the fuel cell (the ratio of the maximum power of the cell after continuous use for 1,000 hours or more to the initial maximum power of the cell) is also enhanced.

As disclosed in the specification at page 21, lines 2 to 10, particularly when VGCF is heat-treated at 2,500°C or higher, the resultant VGCF of high crystallinity exerts remarkable effect of enhancing such fuel characteristics. Therefore, in the present fuel cells and assemblies, the degree of graphitization-crystallization of VGCF is enhanced by means of addition of boron. Mixing of a boron compound and VGCF may be carried out by means of any method without use of a special apparatus, so long as they are carefully mixed so as to form a uniform mixture.

Since JP '571 does not disclose or suggest a graphitized vapor grown carbon fiber, applicants submit that JP '571 does not disclose or render obvious the subject matter of the present claims.

Turning now to the Nishimura et al patent, it discloses a graphitized carbon fiber containing boron in an amount of 0.1 to 10% and having a diameter of 10-1,000 nm.

However, although Nishimura et al may disclose the fiber in connection with a lithium battery electrode or a field-emission display (FED), or as an addition to a resin, Nishimura et al. does not disclose the graphitized carbon fiber in a fuel cell or in a solid polymeric electrolyte-type fuel cell, as in the present case.

Thus, Nishimura et al relate to an invention mainly used for a lithium battery, and a description regarding a fuel cell is not present in Nishimura et al. See, for example, column 1, lines 16 to 27, column 11, lines 28 to 33 and Example 7 of Nishimura et al. Accordingly, applicants submit that one of ordinary skill in the art cannot arrive at the subject matter of the present claims, even if the teachings of Nishimura et al are combined with the teachings of EP '638 and JP '571, because there is no teaching in any of the references to employ a graphitized vapor grown carbon fiber in a fuel cell or in a membrane-electrode assembly for a fuel cell.

Therefore, Nishimura et al do not suggest using a graphitized vapor grown carbon fiber containing boron in an amount of 0.01-100 mass% and having a diameter of 100-300 nm in a gas diffusion layer of a fuel cell, particularly the present solid polymeric electrolyte-type fuel cell.

Thus, it is difficult for a person skilled in the art to combine EP '638 with JP '571 and Nishimura et al to derive the fuel cells and assemblies as claimed in Claims 1, 17, 21, 22 and 29.

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Hager et al are directed to a process for producing near net shape carbon engine pistons and other artifacts by sintering homogeneous powders derived from petroleum pitch. The homogeneous powders can optionally be mixed with carbon fibers to produce carbon-carbon composites. Hager et al disclose that the carbon fibers that can be mixed with the process can be PAN carbon fibers, pitch carbon fibers or vapor grown carbon fibers.

Hager et al disclose at column 11 that their invention is particularly useful for carbon pistons, and disclose at column 12 that other components that can be made by their invention include "battery separators, e.g., for lithium ion batteries, fuel cell components, e.g., separators and electrodes; satellite components, e.g., joint and structural members and various engine parts, e.g., valve guides and tuppets, turbine bearings, etc. in all of which the dimensional stability will be valuable."

This disclosure at column 12 is the only mention of fuel cells in Hager et al and does not disclose that the vapor grown carbon fibers, which are an optional component of the Hager et al invention, are used in fuel cells. Hager et al do not contain any disclosure of the use of vapor grown carbon fibers in a fuel cell, and do not disclose that vapor grown carbon fibers should be used in the gas diffusion layer of a fuel cell.

Applicants submit that the examiner is employing hindsight by relying on a passing reference to fuel cells in Hager et al, which reference does not indicate that the optional vapor grown carbon fibers disclosed in Hager et al should be used in fuel cells.

Moreover, Hager et al do not disclose or suggest that a graphitized vapor grown carbon fiber containing boron in an amount of 0.01-10 mass% and having a diameter of 100-300 nm, as in the present claims, should be used in a gas diffusion layer of a fuel cell.

In view of the above, applicants submit that Hager et al. do not provide the clear and particular motivation that would have been necessary for one of ordinary skill in the art to modify EP '638 and arrive at the claimed fuel cells and assemblies.

Masuko et al.'s disclosure "relates to fine carbon composite powder useful as an electrically conducting material for an electrode material used particularly in a Lithium(Li) battery, electrical double-layer capacitor and the like, and fine carbon composite powder useful for supporting a catalyst for use in a fuel battery, and also relates to the method for producing the powder, a catalyst for polymer electrolyte fuel battery using the carbon composite powder, a polymer electrolyte fuel battery cell and battery using the catalyst." See paragraph [0002] of Matsuko et al.

However, the electrode disclosed in Masuko et al is different from both the present electrode and the materials or the applications disclosed in the other references.

Further, examples in Masuko et al employ carbon fibers in a catalyst layer. The presently claimed fuel cells and assemblies comprise a gas diffusion layer comprising the graphitized vapor grown carbon fibers. A fuel cell and a secondary battery are different from each other. The inventor found that graphitized vapor grown carbon fiber has an improved hydrophobicity and a suitable space therein, so that it can be advantageously used in a gas diffusion layer of a fuel cell. These issues do not exist in a secondary battery.

Therefore, applicants submit that it is difficult for a person skilled in the art to combine EP '638 with JP '571 and Nishimura et al to derive the subject matter claimed in Claims 1, 17 and 29, even in view of Masuko et al's disclosure.

Iijima discloses at column 7, lines to 41 to 48, that the electrode can be used in various batteries, such as a primary battery, a secondary battery, and a fuel cell.

However, the electrode disclosed in Iijima is different from both the present electrode and the materials or the applications disclosed in the other references.

In addition, Iijima does not disclose or suggest that graphitized vapor grown carbon fibers can be employed in a gas diffusion layer in a fuel cell. A fuel cell and a secondary battery are different from each other. The inventor found that graphitized vapor grown carbon fiber has an improved hydrophobicity and a suitable space therein, so that it can be advantageously used in a gas diffusion layer of a fuel cell. These issues do not exist in a secondary battery.

Therefore, it is difficult for a person skilled in the art to combine EP '638 with JP '571 and Nishimura et al to derive the subject matter claimed in Claims 1, 17 and 29, even in view of Iijima's disclosure.

In view of the above, applicants submit that the cited documents do not disclose or suggest the subject matter of the rejected claims and, accordingly, request withdrawal of the §103 rejection of Claims 1, 17-18, 21-24, 26-27, and 29-30.

II. RESPONSE TO REJECTION UNDER 35 U.S.C. § 103

Claims 19 and 20 have been rejected under 35 U.S.C. § 103(a) as obvious over EP '638 in view of JP '571, Nishimura et al, Hager et al, Masuko et al, Iijima, and further in view of Fischer et al.

Applicants submit that these documents do not disclose or render obvious the subject matter of the above claims and, accordingly, request withdrawal of this rejection.

Claims 19 and 20 ultimately depend from claim 17. Accordingly, applicants submit that these claims are patentable for the same reasons as discussed at Section I above in connection with Claim 17.

In view of the above, applicants submit that the cited documents do not disclose or suggest the subject matter of the claims 19 and 20 and, accordingly, request withdrawal of this §103 rejection.

III. CONCLUSION

In view of the above, reconsideration and allowance of this application are now believed to be in order, and such actions are hereby solicited. If any points remain in issue which the Examiner feels may be best resolved through a personal or telephone interview, the Examiner is kindly requested to contact the undersigned at the telephone number listed below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

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Date: September 25, 2006

CERTIFICATION OF FACSIMILE TRANSMISSION

Sir:

I hereby certify that the above identified correspondence is being facsimile transmitted to Examiner Gregg CANTELMO at the Patent and Trademark Office on September 25, 2006, at 571 273 8300.

Respectfully submitted,

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